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Supplementary material for

Superior lead-free high-temperature piezoceramics of $BiFeO_3$-$BaTiO_3$-$(Bi_{0.5}Na_{0.5})TiO_3$ through cooperative regulation

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Table S1. Rietveld refined structural parameters of the BF(MN)$_x$-BT-BNT ceramics.

x	Phase	Fraction (%)	Lattice parameters	R_{wp} (%)	R_p (%)	χ^2
0.	R	59	a=b=5.6514 Å, c=13.8960 Å, α=β=90^o, γ=120^o	9.82	2.73	1.86
	Pc	41	a=b=c=4.0008 Å, α=β=γ=90^o			
0.001	R	62	a=b=5.6507 Å, c=13.9077 Å, α=β=90^o, γ=120^o	10.17	2.94	1.89
	Pc	38	a=b=c=3.9951 Å, α=β=γ=90^o			
0.002	R	53	a=b=5.6516 Å, c=13.9057 Å, α=β=90^o, γ=120^o	9.94	2.87	1.78
	Pc	47	a=b=c=3.9957 Å, α=β=γ=90^o			
0.003	R	49	a=b=5.6525 Å, c=13.9049 Å, α=β=90^o, γ=120^o	9.68	2.65	1.71
	Pc	51	a=b=c=3.9973 Å, α=β=γ=90^o			
0.004	R	45	a=b=5.6488 Å, c=13.9105 Å, α=β=90^o, γ=120^o	9.92	2.97	1.68
	Pc	55	a=b=c=3.9995 Å, α=β=γ=90^o			
0.005	R	37	a=b=5.6485 Å, c=13.9152 Å, α=β=90^o, γ=120^o	10.12	3.02	1.89
	Pc	63	a=b=c=4.0015 Å, α=β=γ=90^o			

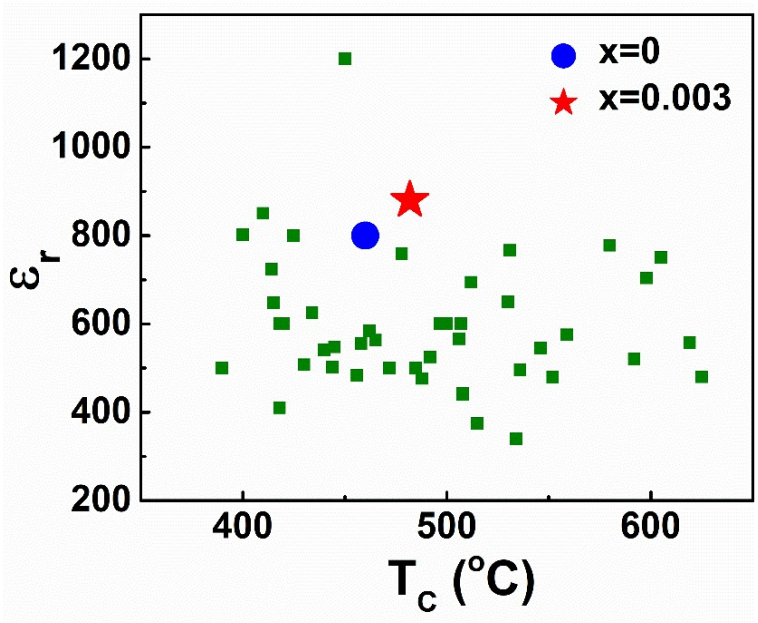

Fig. S1. The comparison of room temperature ε_r and T_c values for various BF-BT-based ceramics [Ref. 20-33 in the main text].

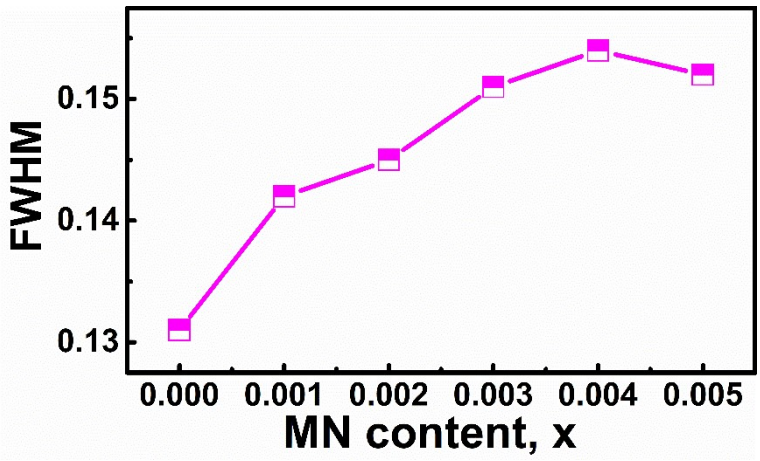

Fig. S2. The variation of FWHM for the BF(MN)$_x$-BT-BNT ceramics.

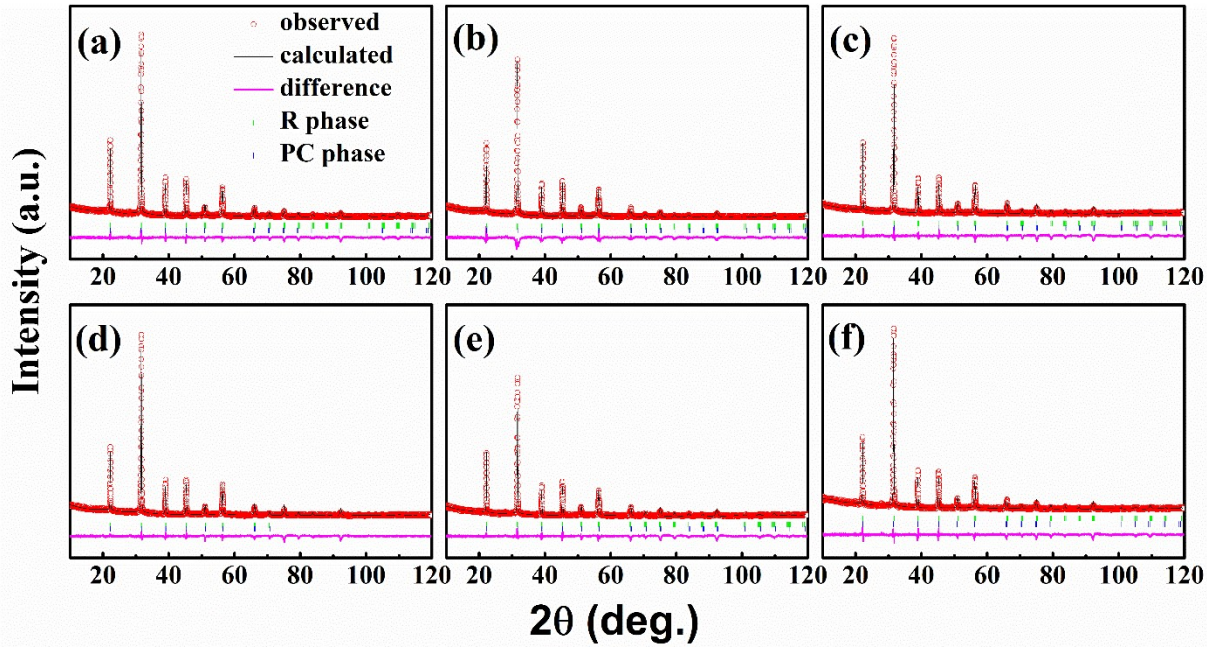

Fig. S3. (a-f) Rietveld refinement of BF(MN)$_x$-BT-BNT ceramic powders: (a) $x = 0$, (b) $x = 0.001$, (c) $x = 0.002$, (d) $x = 0.003$, (e) $x = 0.004$, and (f) $x = 0.005$.

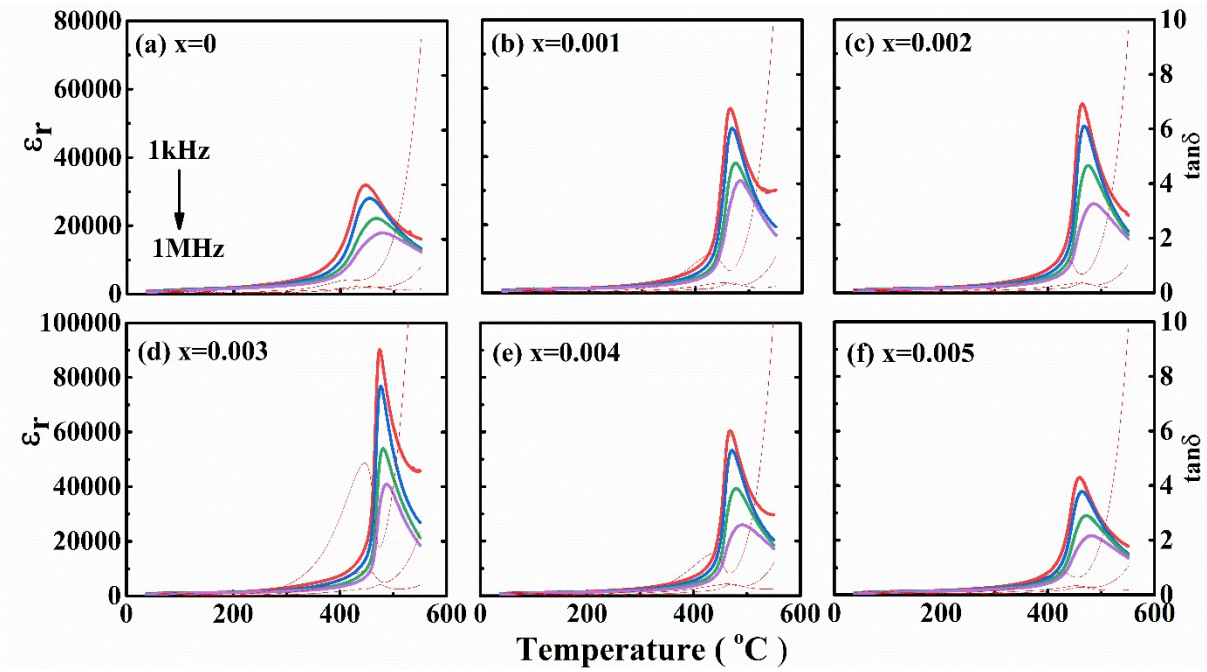

Fig. S4. Temperature-dependent ε_r-T and $tan\delta$-T curves at different frequency for $BF(MN)_x$-BT-BNT ceramics.

The dielectric relaxation characteristics of the relaxor FE ceramics can generally be described by two parameters γ and ΔT_{relax}, in which γ can be calculated by a modified Curie-Weiss law $1/\varepsilon_r - 1/\varepsilon_m = (T-T_m)\gamma/C$ $(T > T_m)$, and ΔT_{relax} can be defined as the difference between two T_m values measured at 1 MHz and 1 kHz, respectively. The calculated γ and ΔT_{relax} values according to Fig. S4 are shown in Fig. S5.

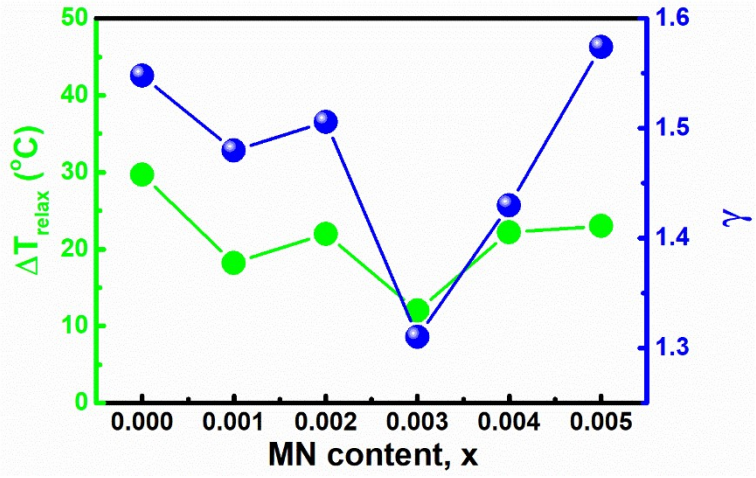

Fig. S5. The variation of γ and ΔT_{relax} as a function of x.